Wiz

by Pocket Neurobics

Bio-Signal Acquisition since 2000
USER MANUAL

v1.2 - first draft - added USB & concurrent wireless transport mode
v1.3 - second draft - added E/H/W/N Wiz to product suite

Quick Start

- Install PC Application (BioExplorer, BioEra etc) - needs to be latest version, see copy on CD
- plug Q/E/H-wiz into USN port and allow Windows to search for Pocket Neurobics driver in it's on-line repository
- or, for W/N-wiz, plug PN wireless dongle into USB port
- as part of the Windows driver installation procedure, note the COM port number assigned to the Pocket Neurobics device by Windows
- only if driver installation fails, try the manual driver executable on the PN CD under 'utilities'
- transfer illustrative BioExplorer and BioEra designs into respective directories on your PC
- transfer media resources, video and audio files, into respective directories on your PC
- open the PC Application, go to Device Configuration, enable the "PN Wiz" driver, and configure it for the COM port assigned by Windows
- open the illustrative design "Wiz_Test"

With successful installation, the Application should show the Wiz's start-up test sequence for the seconds after it is powered on.

Feature Set

Feature Set	**Wiz Model:**	**Q**	**E**	**H**	**W**	**N**
Modes		0..4	0..3	0..2	0..3	0..2
Maximum sampling rate per slot		512sps	512sps	128sps	512sps	128sps
4 slots		X				
2 slots		X	X	X	X	X
EEG/ECG/EMG/SCP		X	X		X	
NIR/PIR/Pulse		X		X		
NIR		X		X		X
Wireless &/or USB		X	X	X		
Wireless only (8 wireless channels, 5m range)					X	X
EEG 21-ch Cap Interface & Control		X				
Real-time 8-LED display of signal on Slot 1		X	X	X		
24-bit resolution		X	X		X	
16-bit resolution				X		X
DC-coupled (under User control)		X	X		X	
Linking of Reference electrodes (user control)		X	X		X	
Auto-baselining of HEG		X		X		X
Auto detection of Headband connection		X		X		X
Auto configuration of Slots for AC, DC signals		X				
Detection of electrode lead-off		X	X		X	

Detection of poor signal	X	X	X	X	X
Vibration when signal quality changes		X	X		
Remembers configuration	X	X	X	X	X
Self-test at startup	X	X	X	X	X
Signal Generator Mode	X	X	X	X	X
Firmware Upgradeable	X	X	X	X	X
Failsafe Mode	X	X	X	X	X

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1. Overview

The Wiz is a bio-signal acquisition device. The devices in the series capture bio-signals such as eeg and blood oxygenation measures and forwards them via USB or wireless to an Application running on a PC which has a Wiz driver to correctly interpret the signals being sent. The Wiz will typically be used as an element in a bio-feedback training system.

In this manual, the following terms are used:

- "Modality": the type of bio-signal being acquired - eeg, emg, ecg, scp, nIR, pIR, and pulse oximetry are modalities
- "Channels": the number of channels of each modality. For example 2 channel nIR can be carries over 4 transport slots of the Q-wiz.
- "Transport Slot": the total number of Channels of various modalities that can be transported from the Device to the PC.
- "Mode": the Mode of a device indicates its current configuration - the number of slots transported, the sampling rate of those slots, and gain or amplification of each slot.
- "sps": samples per second, or how fast the bio-signal is samples. EMG needs a fast sampling rate, whereas the blood oxygenation modalities can use a much slower sampling rate and thus use less of the PC's processing resources.

There are five products currently defined in the Wiz product suite:

- Q-wiz: 2/4ch EEG/hHEG, usb/wireless, with eeg cap interface, implementing Modes 1..4
  - Q for mini-Quantitative Assessment
- E-wiz: 2ch EEG, usb/wireless, implementing Modes 1..3
  - E for EEG
- H-wiz: 2ch HEG, usb/wireless , implementing Modes 1..2
  - H for HEG
- W-wiz: 2ch EEG wireless, implementing Modes 1..3
  - W for wireless
- N-wiz: 2ch HEG wireless, implementing Modes 1..2
  - N for nIR HEG

Applications supporting the Wiz suite are:

- BioExplorer (www.cyberevolution.com)
- BioEra (www.bioera.net - future)

The Wiz suite flexibly supports 1 to 4 transport slots. The modalities in those slots fall into two categories:

(i)AC (alternatibg current) signals:

- EEG, elecroencephalography, 1 to 4 chanels
- SCP, slow cortical potentials, 1 to 4 channels
- ECG, electrocardiography, 1 to 4 chanels, and
- EMG, elecromyography. 1 to 4 channels.

(ii) DC (slowly varying Direct Current) signals:

- nIR HEG, near infrared hemoencephalography , one or two channels
- pIR HEG, passive infrared hemoencephalography, one channel
- pulse oximeter sensing the pulse rate

EEG, SCP, ECG, and EMG all use the same silver or silver/silver-chloride electrode interface, whereas nIR

and pIR HEG blood oxygenation sensors use special headbands. The nIR HEG sensor input can also accept a pulse oximeter input.

The Q-Wiz supports all modalities and up to 4 slots, whereas the E-wiz and the P-wiz support the AC modalities, and the H-wiz and the N-wiz sport DC modalities, and the latter four devices support 2 slots.

Wiz devices automatically detect when a headband or finger sensor is connected and reconfigure accordingly. When only one modality is used, it will appear on slot 1. For devices that support both AC and DC modalities, namely the Q-wiz, when no headbands or finger sensors are connected slots will default to AC - ie 2 or 4 channels of EEG etc.

The PC Application will automatically detect which modality is assigned to which slot and adjust accordingly.

The Q-wiz supports all Modes and other devices in the suite support Modes 1..3 or Modes 1..2. The mapping of Modality into transport slot changes according to which headband or finger sensor is connected, and which Mode is selected:

Mode	Slot:	Slot1	Slot2	Slot3	Slot4
<Mode 1> 32sps - used for HEG (and EEG protocol processing - future)					
<Mode 2> 128sps - Hi resolution EEG and HEG					
<Mode 3> 512sps - EMG, ECG and SCP (and EEG if mixed modalites)					
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no headband sensed		EEG1	EEG2		
nIR sensed		NIR1	NIR2*		
nIR & pIR sensed		NIR1	PIR1		
pIR sensed		PIR1	EEG1		
PULS sensed		PULS1	EEG1		
pIR & PULS1 sensed		PULS1	PIR1		

<Mode 4> 256sps 4ch - mixed modes					
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no headband sensed		EEG1	EEG2	EEG3	EEG4
nIR sensed		EEG1	EEG2	NIR1	NIR2
nIR & pIR sensed		EEG1	EEG2	NIR1	PIR1
pIR sensed		EEG1	EEG2	EEG3	PIR1
PULS sensed		EEG1	EEG2	EEG3	Oxi1
pIR & PULS sensed		EEG1	EEG3!	Oxi1	PIR1

All devices also have a Mode 0, or Program Mode, which is selected to allow firmware updates, or, in the case of wireless operation. to allow the PC to send Commands to the device (see section on Commanding the device).

The Q/E/H-wiz can operate wirelessly or by direct USB connection. The P/N-wiz operate wirelessly only. Wireless operation requires a PN wireless dongle connected to a USB port. Devices that operate either wirelessly or by direct USB connection will automatically choose direct USB connection when a direct USB connection is recognised ("enumerated").

2. Buttons

All units have a Mode button. A short press sequences thru the available Modes. Mode is indicated by a blinking green light. For Mode 1, the light blinks once. For Mode 0, or Program Mode, the light does not blink.

Modes are consistent across models. Mode 2 on the Q-wiz has the same attributes as Mode 2 on the E-wiz. But not all models support all modes.

The Mode button also serves as a 'Signal Good' indication. This indication is an assessment of the quality of signal on all active slots. When the signal is judged as good then the Green light is mostly on and blinks off. If the signal cannot be judged Good, then the green light is off and blinks on.

On the Q-wiz, a long press of the Mode button activates the EEG Cap interface at which time the 8-LED indicator reports the status of the Cap multiplexer.

All models have a second button which controls key functions of the active modality. For EEG/ECG/EMG/SCP modalities, the Link/Freeze button toggles a link between the two reference electrodes and also toggles whether the DC (direct current) component of the signal is removed or not. A short press of the button toggles the link action, with a green light indicating that the references are currently linked. A long press (>2sec) toggles whether the DC component is removed from the signal or whether the DC is not removed ("frozen") which is indicated with a blue light. DC-coupling is preferred for ECG and SCP signal sampling and should be used with Ag/AgCl electrodes.

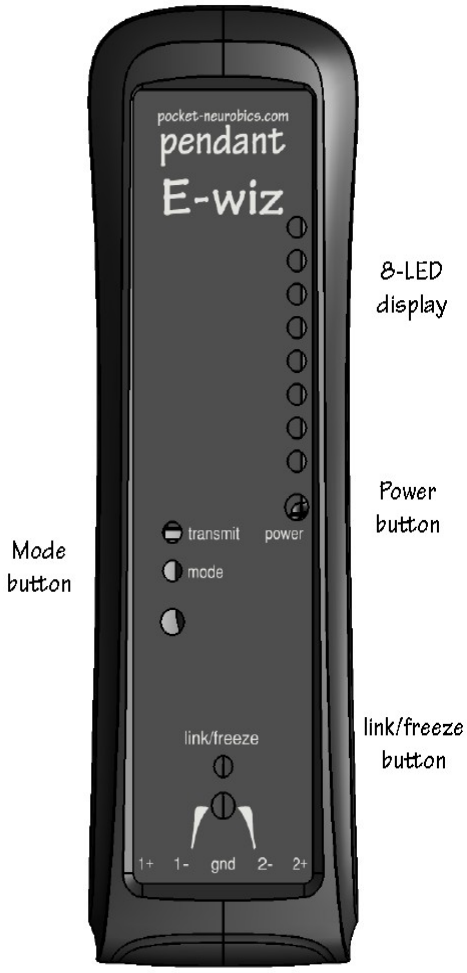
Some unit shave a Power-On button and some not. If there is not a Power-On button, then the unit can be de-powered by removing the USB cable (or switching off at a USB mini-hub with a power switch), or by placing the unit in Program Mode (Mode 0).

Q-wiz:

- Mode button (green):
  - short press, sequences thru Modes
  - long press, activates the Q-menu and the Cap interface
  - pressed at power-up: enter fail-safe mode. Operates with base feature set. Mode for recovery should firmware become corrupted.
- Link (green) & Freeze (blue) button:
  - short press, controls linking of EEG references, and initiates nIR/pIR/pulse HEG baseline search.
    - in Mode 0 and wireless transport, increments rf channel (in USB Transport, use Application to change wireless channel if required)
    - in Mode 0 and USB transport, toggles between USB transport only and USB and wireless transport concurrently (Transport LED blinks with wireless channel number when wireless is active)
  - long press, controls freezing and unfreezing EEG DC removal
  - pressed at power-up: initiates Signal Generator mode
- there is no Power On button for the Q-wiz.
- both Mode & Link Buttons together
  - to exit Signal Generator Mode (or simply remove the power from the unit & re-start)
  - when in Q-menu mode, @ "Program Mode", pressing the Link and Mode button enters/exits programming of the User-defined switching of the Cap (see section of the Q-menu).

E-wiz:

- Mode button (green):
  - short press, sequences thru Modes
  - pressed at power-up: enter fail-safe mode. Operates with base feature set. Mode for recovery should firmware become corrupted.
- Link (green) & Freeze (blue) button:
  - short press, controls linking of EEG references
    - in Mode 0 and wireless transport, increments rf channel (in USB Transport, use Application to change wireless channel if required)
    - in Mode 0 and USB transport, toggles between USB transport only and USB and wireless transport concurrently (Transport LED blinks with wireless channel number when wireless is active)



- long press, controls freezing and unfreezing EEG DC removal
- pressed at power-up: initiates Signal Generator mode

- Power On Button
  - toggles normal operation and power off

H-wiz:

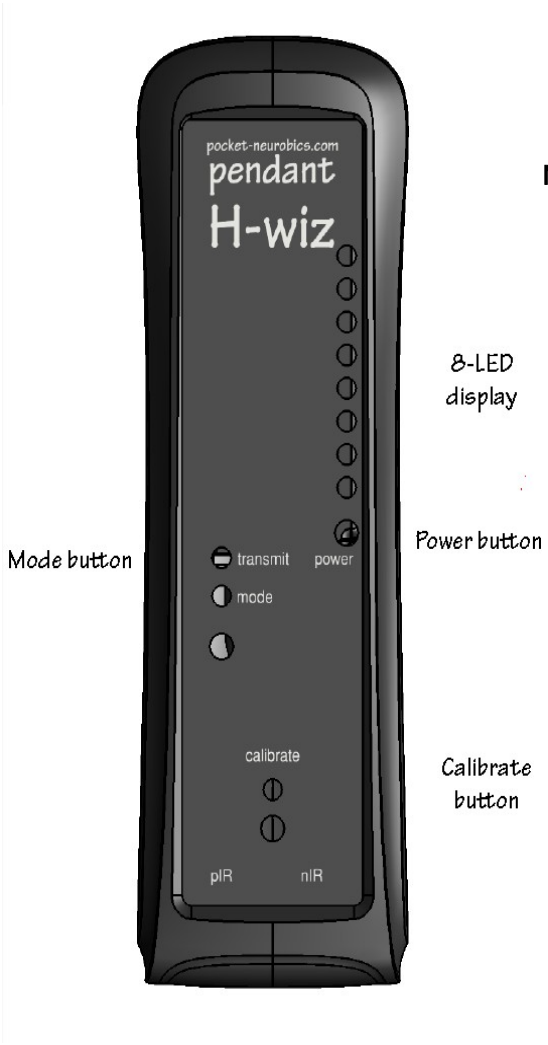
- Mode button (green):
  - short press, sequences thru Modes
  - pressed at power-up: enter fail-safe mode. Operates with base feature set. Mode for recovery should firmware become corrupted
- Calibrate (green) button:
  - short press, initiates nIR/pIR/pulse HEG baseline search for nominal value of 100
    - in Mode 0 and wireless transport, increments rf channel (in USB Transport, use Application to change wireless channel if required)
    - in Mode 0 and USB transport, toggles between USB transport only and USB and wireless transport concurrently (Transport LED blinks with wireless channel number when wireless is active)
- pressed at power-up: initiates Signal Generator mode
- Power On Button
  - toggles normal operation / power off

W-wiz:

- Mode button (green):
  - short press, sequences thru Modes
  - pressed at power-up: enter fail-safe mode. Operates with base feature set. Mode for recovery should firmware become corrupted.
- Link (green) & Freeze (blue) button:
  - short press, controls linking of EEG references
    - in Mode 0 and wireless transport, increments rf channel (in USB Transport, use Application to change wireless channel if required)
    - in Mode 0 and USB transport, toggles between USB transport only and USB and wireless transport concurrently (Transport LED blinks with wireless channel number when wireless is active)

  - long press, controls freezing and unfreezing EEG DC removal
  - pressed at power-up: initiates Signal Generator mode

  - Wireless Channel button:
    - increments wireless channel number when in Mode 0 (Program Mode). Sequences thru channels 1..8



- Power On Button
  - toggles normal operation and power off

N-wiz:

- Mode button (green):
  - short press, sequences thru Modes
    - pressed at power-up: enter fail-safe mode. Operates with base feature set. Mode for recovery should firmware become corrupted.
- Calibrate (green) button:
  - short press, initiates nIR/pIR/pulse HEG baseline search for nominal value of 100
    - in Mode 0 and wireless transport, increments rf channel (in USB Transport, use Application to change wireless channel if required)
    - in Mode 0 and USB transport, toggles between USB transport only and USB and wireless transport concurrently (Transport LED blinks with wireless channel number when wireless is active)
- pressed at power-up: initiates Signal Generator mode
- Wireless Channel button:
  - increments wireless channel number when in Mode 0 (Program Mode). Sequences thru channels 1..8
- Power On Button
  - toggles normal operation and power off

3. LED Indicators

Q-wiz:

TRANSMIT {blue):
- On Steady: sending to Application via USB
- On Blink: sending wirelessly
- Off Blink: not transmitting to Application (ie Program Mode)
- Blink: wireless channel number

MODE/GOOD (green):
- On: no EEG lead off, and/or nIR full signal strength, and/or pIR valid reading
- Off: EEG lead off, or nIR not full strength, or pIR reading out of range
- Blink: Mode 0/1/2/3/4 = Program/32sps(2ch)/128sps(2ch)/512sps(2ch)/256sps(4ch)

LINK (blue/green):
- Blue On: EEG baseline frozen (DC coupled)
- Blue Off: DC removal - EEG low frequency response ~0.2Hz
- Green On: EEG References linked - only one Reference electrode required
- Green Off: EEG References independent - two References required for 2 eeg channel operation

HEG (yellow):
- On: when nIR, pIR or Oxi headband sensed
- Off: no headband sensed, all 2/4 channels used for EEG
- Blink: when nIR/pIR/pulse baseline search for nominal value of 100 is under way
- Fast Flash: indicates that User Defined configuration of the Cap is currently being programmed

E-wiz:

TRANSMIT {blue):
- On Steady: sending to Application via USB
- On Blink: sending wirelessly
- Off Blink: not transmitting to Application (ie Program Mode)
- Blink: wireless channel number

MODE/GOOD (green):
- On: no EEG lead off
- Off: EEG lead off
- Blink: Mode 0/1/2/3 = Program/32sps(2ch)/128sps(2ch)/512sps(2ch)

LINK (blue/green):
- Blue On: EEG baseline frozen (DC coupled)
- Blue Off: DC removal - EEG low frequency response ~0.2Hz
- Green On: EEG References linked - only one Reference electrode required
- Green Off: EEG References independent - two References required for 2 eeg channel operation

H-wiz:

TRANSMIT {blue):
- On Steady: sending to Application via USB
- On Blink: sending wirelessly
- Off Blink: not transmitting to Application (ie Program Mode)
- Blink: wireless channel number

MODE/GOOD (green):
- On: nIR full signal strength, and/or pIR valid reading
- Off: nIR not full strength, or pIR reading out of range
- Blink: Mode 0/1/2 = Program/32sps(2ch)/128sps(2ch)

CALIBRATE (blue):
- On: when nIR, pIR or Oxi headband sensed
- Off: no headband sensed, sends test signal to PC Application
- Blink: when nIR/pIR/pulse baseline search for nominal value of 100 is under way

W-wiz:

BLUE:
- On: EEG baseline frozen (DC coupled)
- Off: DC removal - EEG low frequency response ~0.2Hz
- Blink(Mode 0 only): wireless channel number

GREEN:
- On: EEG References linked - only one Reference electrode required
- Off: EEG References independent - two References required for 2 eeg channel operation
- Blink: Mode 0/1/2/3 = Program/32sps(2ch)/128sps(2ch)/512sps(2ch)

N-wiz:

BLUE:
- On: when nIR, pIR or Oxi headband sensed
- Off: no headband sensed, sends test signal to PC Application
- Blink: when nIR/pIR/pulse baseline search for nominal value of 100 is under way
- Blink (Mode 0): wireless channel number

GREEN:

- On: nIR full signal strength, and/or pIR valid reading
- Off: nIR not full strength, or pIR reading out of range
- Blink: Mode 0/1/2 = Program/32sps(2ch)/128sps(2ch)

4. Connecting to PC: Wireless and USB Transport

All models can transmit wirelessly. The W-wiz and the N-wiz are exclusively wireless. The Q/E/H-wiz can transmit either wirelessly or directly via USB cable. The Q/E/H-wiz can also transmit both directly via USB cable and wirelessly.

The Q-wiz can be powered from a normal USB port or by a "USB Portable Power" battery. In the case of the latter, the Q-Wiz will automatically recognise that it does not have a USB connection and start to transmit wirelessly. A PN proprietary dongle is required to receive the wireless signal.

The E-wiz and the N-wiz can be powered from either a USB port or 2x AA batteries placed inside the unit. The batteries are not needed for USB operation.

The Q/E/H-wiz will default to direct USB communication if it is sensed that the power is derived from a USB port. If not, they will transmit wirelessly. No manual intervention is required.

The W-wiz and the N-wiz operate from a single AAA battery inside the unit.

In cases where the computer is slow to enumerate the Q-wiz when connected, then the Q-Wiz may decide that it is not connected to a USB port and begin transmitting wirelessly. Unplugging the unit and re-inserting should have it enumerate correctly. If this happens persistently then the Q-wiz can be started in fail-safe mode (see below) which grants a longer period for USB enumeration.

Concurrent Wireless and USB Transport

For the Q/E/H-wiz, when in USB Transport and Program Mode, a short press of the "Link" button will toggle between having USB Transport only (the blue "Transmit" LED will be on steady), and having both USB and Wireless Transport concurrently (signified by the blue "Transmit" LED being mostly on and blinking off). This dual mode allows "training room" scenarios whereby USB connection is used to communicate with the PC at each training seat, and wireless communication is used to a central control position which can scan the progress of each training seat, or select one for closer monitoring. This setting is remembered from session to session, but note that wireless operation can cause interference to other devices operating wirelessly - each device will need its own wireless channel.

Changing Wireless Channels

When multiple Wiz's are operating in close proximity, each must have a separate wireless channel. There are eight wireless channels available.

When in Wireless Transport (ie battery powered)

- the wireless channel number is incremented by choosing Mode 0 (Program Mode), then a _short_ press of the "Link" button
- the PC Application cannot command a change to the wireless channel

In USB transport mode

- the Application may have the ability to change wireless channels of the Wiz, and if so,
- the wireless channel number can be changed either in Program Mode (Mode 0) or in the Operating Modes.

A new wireless channel number is remembered from session to session.

Separately, the PN wireless dongle needs to be set to the same wireless channel as that of the Wiz. That is, the wireless dongle needs to be blinking at a rate the same as the Wiz. When the PN wireless dongle is

successfully receiving a signal, it's green LED is on and blinks off. The wireless channel of the dongle can be changed either by _short_ presses of its button, or by commands from the PC Application if the Application has that ability.

5. Modes

A _short_ press of the Mode button will change modes.

There are five Modes:

- Mode 0
  - Program Mode, for uploading upgrades, interrogating version numbers etc
- Mode 1
  - two transport slots at 32sps sampling rate: low transmission rates to minimise burden on PC processor
  - recommended for HEG & SCP only, not suited for use with EEG, EMG or ECG
- Mode 2
  - two slots at 128sps sampling rate: most sensitive and low rates to minimise burden on PC processor
  - recommended for EEG and SCP
- Mode 3
  - two slots at 512sps sampling rate for high bandwidth, 4x lower sensitivity
  - recommended for ECG/EMG/SCP
- Mode 4 (Q-wiz only)
  - four slots at 256sps sampling rate, high sensitivity
  - recommended for 4 channel EEG, or mixed modalities

Mode changes are signified to the PC Application automatically, and the Application's interface will reconfigure in sympathy. For some changes, like changing from 2-slot modes to 4-slot mode, the Application's input may need to be manually reconfigured. Note that the Source Objects of the BioExplorer Application have the ability to auto detect the modality of incoming signals such that if there is one Source Object configured for EEG and another for HEG, then BioExplorer will automatically connect the correct Source object to correct incoming stream. It does this on the fly.

Further, where there is a single channel of a single modality, then it will always appear on on the first input to the Application, that is, Slot 1. Thus single channel protocol designs can assume the input is always the first input.

6. EEG Electrode Interface

The Q-Wiz can operate as a single channel eeg, 2-channel eeg, 3-channel eeg, or 4-channel eeg. The E/W-wiz can operate as single or two channel eeg. If using EEG, EEG Channel 1 must be one of the channels being used, however there are no constraints on which other channels are used. A Ground connection ("gnd") is also required for all EEG configurations. Thus the minimum arrangement for EEG use is three elecrodes: 1+, 1-, and gnd.

The Wiz is a 24-bit resolution, directly coupled device. However the default mode of operation is to slowly remove the DC component of the EEG so the signal does not wander and potentially move out of range of the PC Application. This virtual High Pass Filter is set at about 0.2Hz. A _long_ press of the "Link/Freeze" button will override DC removal, and a blue LED will light to signify that the DC-removal is now frozen (_blue_ for _frozen_) and the amplifier will then act as a true DC-coupled device. Freezing the DC removal operation is used with SCP and ultra-low frequency EEG modalities. Another long press will re-activate DC-removal and extinguish the blue LED. Freeze state is not remembered and will need to be set each time the unit is powered on.

The amount of DC-offset removal can be remembered by the Wiz, allowing the eeg to settle faster when next powered on. Offsets are grabbed at the time of freezing the eeg with a long press of the Freeze button.

A _short_ press of the "Link" button will electrically join the two Reference electrodes (1- and 2-) adjacent to the Link button and a Green LED will light to signify that the references are linked. Another short press will unlink and extinguish the Green LED. (_green_ for _link_). Linking of electrodes is typically used for assessment procedures. Link state is remembered - the device will power-up in the state previously set.

For the Q-wiz, EEG channels 3 and 4 do not have their own separate reference electrode. EEG Channel 3 uses 1- as its reference and EEG Channel 4 uses 2- as its reference. If the green "Link" light is on, then all four electrodes are sharing a common reference and only one reference electrode need be connected to the body, although typically two reference electrodes are still used, one to each ear-lobe.

7. HEG Interface

The Q/H/N-wiz senses when a HEG (either nIR, pIR, or pulse) headband is connected. The "HEG" LED will begin to flash, signifying that the unit is adjusting the signal to it's nominal value of 100. Once the nominal value is found, the device automatically Freezes the baseline and the "HEG" LED stops flashing and becomes steady on. The Wiz is then ready for training.

Note that the unit will attempt to find the nominal value whether the headband is on the head or not, so if a false nominal value has been set, then a _long_ press of the "Calibrate" or "Link" button will initiate a new search. Nominal values are found after 5 to 15 seconds of searching.

The offset required to establish the nominal value of 100 is remembered allowing HEG to settle faster next time it is powered-on. Offsets are grabbed at the time a nominal value of 100 is achieved. These offset values will then be saved to memory when there is either a mode change or a short press of the Link/Freeze button. For both nIR and pIR HEG, should the limits of the range of reading be exceeded, then a search for the nominal value of 100 is automatically re-started.

If in a 2-slot mode (ie Mode 1, 2, or 3) and just one headband is in use, either pIR or nIR, then the signal will appear on Slot 1. This means that changing from pIR to nIR modality is as simple as changing headbands - no reconfiguration of the Wiz or PC Application is required.

The Wiz supports 2-ch nIR Headbands. If the Wiz senses that the current headband supports only one nIR channel, then it substitutes the Infrared component of the nIR1 signal on the nIR2 slot. This IR signal can be used to gauge the quality of the nIR1 signal, and can be used by the application to derive the Pulse Rate from the nIR signal, for say HRV training.

8. Other Sensors

Nellcor compatible SpO2/Pulse Oximeters can interface to the Q/H-wiz via an adaptor. The adaptor allows the sensor to be plugged into the nIR HEG socket on the Wiz. Pulse Oximeters would generally be used to obtain the pulse bioSignal. Pulse Rate and Heart Rate Variability training can be based on this signal.

Thermocouples can be used to measure skin temperature. In particular, thermocouples which can be grasped are available for the Q/H-wiz for use in training hand-warming. They are connected to the pIR HEG socket.

9. 8-LED Display (Q/E/H-wiz)

The Q/E/H-wiz have an array of eight green LED's to feedback state information to the user. The 8-LED display serves two functions:

- Signal Display mode: real-time display of the signal on transport Slot 1, either EEG (AC) or HEG (DC) depending on mode and whether headbands are connected or not

- Q-menu mode(Q-wiz only): displaying the status of the 21-ch EEG Cap interface (to be described later)

On power-up, the Signal Display mode appears. It can be recognised by flickering of the LEDs, reflecting the real-time nature of the signal being displayed. To enter the Q-menu mode, _long_ press of the Mode button. Q-menu mode can be recognised by a non-flickering LED display, with initially only the top LED lit. Once in Q-menu mode, Signal Display Mode can be re-entered with a _short_ press of the Mode button.

Without headbands connected, the Signal Display shows the real-time display of the EEG signal on transport Slot 1 (ie EEG Channel 1). With "Freeze" off (ie no blue "Link" LED), then the EEG signal should be centered on the display and the magnitude of the EEG will excite LEDs around the center LED. With "Freeze" on (ie blue "Link" LED is on), then the display will reflect DC shifts of the EEG signal. If the display exceeds the LED display range, indicated by the upper-most or lowest LEDs slowly flashing, then this might indicate that the DC level is exceeding safe limits, although the operating range of the EEG signal is considerably greater than the range of the 8-LED display. The EEG signal can be re-centered by a _long_ press of the "Link" button to un-Freeze the baseline. Once centered, the baseline can be re-Frozen with another _long_ press of the "Link" button.

With only one of nIR or pIR HEG headbands connected, the 8-LED display will refect the amplitude of the respective slowly varying DC signal, with the nominal value of 100 being centered on the display. If both pIR and nIR HEG headbands are connected, then the nIR signal appears on transport Slot 1 and is displayed. In nIR HEG mode, the LED display range covers 80 to 120, and in pIR HEG mode the range is 95 to 105. Again, if the 8-LED display range is exceeded, this may or may not be an issue since the operating range of the Wiz is greater than this.

Dithering of the 8-LED display allows for a sensitive, continuously varying signal. Thus the Wiz can be used as a standalone biofeedback trainer for slowly varying DC bio-signals, such as HEG.

10. EEG Cap Interface (Q-wiz only)

The Q-wiz features an interface to a 21 channel EEG cap. Electrocap and Deymed caps are compatible, altho the latter is compatible for 19-ch montages only. The Cap can be used for assessment or training, and the multiplexing of the 21 channels of the Cap onto the 4 slots of the Q-wiz, can be controlled by the PC Application, if it is so capable.

Since there are 21 EEG sites available to the CAP and just 4 slots to the PC Application, there is a choice of which site is to go to which slot. Each Slot can accept one or more of 8 possible Cap sites. Thus we speak of "multiplexing" Cap sites onto available slots, and of a "mapping" of sites onto slots.

The EEG Cap and it's 25-pin D-connector are active and connected whilst the Q-menu is active. The Q-menu is activated by a _long_ press of the Mode button, and is de-activated by a _short_ press of the Mode button. The Cap interface sits across the normal electrode inputs, so both the Cap interface and the normal electrodes can be used at the same time, however in general one should use either the Cap interface or the normal electrode interface but not both. Linking of electrode references by toggling the "Link" button applies equally to the normal electrode input and the references provided by the EEG Cap.

Pre-configured mappings of EEG Cap locations to Slots

A long press of the Mode button will activate the Cap interface. The current Mode is maintained, such that if the unit was in Mode 2 (2ch/128sps) prior to entering in Cap Assessment, then only two of the four slots are available to the Cap. Similarly, if a HEG headband is plugged-in, one or more slots are lost to the Cap interface. In general, select Mode 4 (4ch/256sps) and remove headbands prior to a long press of the Mode button to activate the Cap interface. Once activated, a short press will de-activate the Cap.

There are five pre-configured mappings of selected Cap locations to the four slots which are sent to the Application. These mappings are listed on the _left_ of the 8-LEDs for, left-to-right, Slot 1..4. These five settings sequence through as the result of holding down the Mode button continuously or through a series of long presses.

These five pre-defined mappings accord with 'The Learning Curve' four channel Assessment Procedure (refer www.brain-trainer.com).

User Defined mappings of EEG Cap locations to Slots

A sixth configuration, called User Defined, is programmable. To program the User Defined mapping of EEG Cap locations to slots, scroll down to "Program". In a moment, the 8-LEDs will start to sequence through the currently stored mappings of EEG Cap locations to slots. The 8-LEDs indicate the Cap location listed to the _right_ of the LED. Again, left-to-right, Slot 1..4. The current EEG Cap site identified by the 8-LEDs applies to the Slot indicated by the "Mode" LED, which blinks with the current slot number (one blink for Slot 1 etc). Note that this display is for user information only - so the user can readily see how the User Defined mapping is configured - the Cap interface itself remains fully activated with all slots configured according to the User Defined setting.

Scan Mode

Using _long_ presses of the Mode button to scroll to Scan will cause the EEG Cap locations to sequence through the five pre-set configurations and the User Defined configuration. Dwell time is about 8 seconds, meaning that to sequence through all six mappings takes 48 seconds. Prior to commencement of assessment, Scanning can be used to check that there is a valid eeg signal on each of the Cap locations of interest, both by visual inspection of the eeg trace and Lead-off reporting to the PC Application.

Programming the User Defined Mapping

With the unit sequencing through the current User defined mapping, as described above, pressing _first_ the "Link" button and then, momentarily, the Mode button, enters a mode for Programming the User Defined mapping. To signify this, the "HEG" LED flashes rapidly. This process erases previous User defined mapping.

The "Mode" LED will begin blinking _once_ to indicate that we are currently programming the mapping of EEG Cap locations to Slot 1. The first of the 8-LEDs is lit. In this Programming Mode, _short_ presses of the Mode button will sequence through the choices of Cap location available, whilst momentarily pressing the "Link" button will save that Cap location to the current Slot.

Multiple EEG Cap sites can be selected for a single Slot. The default User Defined mapping maps each quadrant of the scalp to the four slots. Note that not all Cap locations are available to all slots. The possible choices are those listed to the _right_ of the respective 8-LED and in the table below.

By cycling through programming the four slots and returning to a previously programmed slot, re-selecting a particular Cap site will erase that site. Similarly, if a location is accidentally selected, selecting it again will un-select. This happens in real-time,
so selections appear instantly on the Cap interface. To exit and save the new mapping as a new User Defined mapping, press the "Link" button followed by and together with a momentary press of the Mode button. The rapid flashing "HEG" LED will extinguish. To exit Program Mode without saving the new configuration, that is to keep the previous User Defined mapping, simply _long_ press the Mode button. The rapid flashing "HEG" LED will extinguish. This latter method allows individual locations on the EEG Cap to be chosen and observed, without changing the User defined mapping. A _short_ press of the Mode button will then exit the Q-menu entirely and disconnect the EEG Cap interface.

Mappings

	Ch1	Ch2	Ch3	Ch4	
Pre-defined Sequence 1		T3	T4	C3	C4
Pre-defined Sequence 2		F3	F4	P3	P4
Pre-defined Sequence 3		Fz	Pz	Cz	Oz
Pre-defined Sequence 4		F7	F8	T5	T6
Pre-defined Sequence 5	Fp1	Fp2	O1	O2	
Default User Defined Ch1	Fp1/F3/F7				
Default User Defined Ch2	Fp2/F4/F8				
Default User Defined Ch3	T5/O1/P3				
Default User Defined Ch4	T6/O2/P4				

(these default locations are quadrants of the brain - this configuration can be re-programmed)

User Defined Mapping Choices

Choices:	Ch1	Ch2	Ch3	Ch4
	Fp1	Fp2	F7	F8
	F3	F4	T3	T4
	C3	C4	T5	T6
	P3	P4	O1	O2
	F7	F8	C3	C4
	T3	T4	P3	P4
	Fpz	Cz	Cz	Fz
	Fz	Pz	Pz	Oz

Note that sites should not be shared across slots as that will act to short the two eeg channels.

Controlling the Cap's User Defined Mapping from the PC Application

Some supporting Applications include the ability to control the mapping of the EEG Cap onto the 4 slots. If the Q-Wiz is directly connected via USB then the Application can command mapping of the EEG Cap sites on the fly - commands sent from the application will instantaneously configure the EEG Cap and the chosen sites will be conveyed to the Application over the four slots.

If the Q-menu is not active at the time that the Q-Wiz receives a command to map the cap sites, the Q-Wiz will automatically activate the multiplexer and save the new mapping as the User Defined mapping. Also, if not already in Mode 4 (256sps/4ch), the Q-wiz will change to that mode.

If the Q-Wiz is connected via wireless, then select Mode 0 (Program Mode) to allow the PC Application to command mapping of cap sites.

11. Poor Signal Detection

The Wiz monitors

- electrodes for Lead-off condition
- nIR HEG for signal strength
- pIR for values out of range

If any test fails, the "Good" LED is extinguished. This information, on a slot by slot basis, is also sent to the PC Application. That is, each slot is separately reported as Good or not.

12. Test Signals

At power-up, a brief self-test sequence of test signals is sent to the transport slots and to the nIR HEG headband. If the transport slot is configured for EEG use("AC"), then the test signal is a 4, 8, 16, and 32Hz tone, each for one second. If the transport slot is configured for HEG use ("DC"), then the brief test signal is values 99 and 101, each for 1 second.

Additionally, during this power-up self-test phase, control signals to the nIR HEG headband interface separately pulse the Red and the IR LEDs, so that both can be seen with the naked eye. [In normal use, the brightness of the Red LED makes it impossible to see whether the IR is functioning.]

If power is applied to the Wiz with the "Link"/"Calibrate" button pressed, then it will power-up in Signal Generator Mode. In this mode the above test signals are applied indefinitely, until power to the unit is removed, or both the "Link" button and the "Mode" button a pressed simultaneously to exit Signal Generator Mode.

8 sec Self-Test on normal Power-up

EEG - 4/8/16/32Hz, at 1 second intervals
NIR - 99/101 at 1 sec intervals

13. Saving Configurations

When changing Modes, the new Mode is remembered. When the unit is next powered, it will come up in that Mode. After a signal has settled, be it eeg or heg, pressing the Freeze button for 2sec will save the current baseline so that the signal can settle more quickly when that modality is next selected. Functions that get remembered:

- Mode: 32/128/512/256sps, 2ch/4ch
- Baseline offset values
- EEG Reference Link Status (linked or un-linked)
- wireless channel number
- User Defined Cap Mapping

14. Fail-safe Mode

Fail-safe Mode is entered by powering-up with the Mode button pressed. Fail-safe Mode offers base functionality (ie is usable for most functions), and the ability to upload or re-load firmware upgrade packages to restore full functionality. Fail-safe Mode comes up in Mode 2 (128sps/2ch), but other modes can then be selected. Firmware upgrades are restored by placing the unit in Program Mode then using the PC Application Software to upload the latest firmware package available from the pocket-neurobics.com website.

Functions that may not work in Fail-safe mode (model dependant):

- commanding of the Wiz by the PC Application
- pulse oximeter interface

Safety functions in Fail-safe Mode:

- extra time for USB enumeration (for slow PCs)
- freeze button locks current sensor configuration (to stop possible jitter on sensor detection in noisy environments)